AXEL KNAUFF, citizen of Germany, whose residence and post office addresses are Friedrich-Abert-Strasse 20, 97702 Münnerstadt, Germany, has invented certain new and useful improvements in a

ARRANGEMENT FOR MAINTAINING A MACHINE ELEMENT AT A CONTROLLED TEMPERATURE IN ELECTRICALLY OPERATED PRODUCTION MACHINES

of which the following is a complete specification:

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CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the priority of German Patent Application, Serial No. 102 28 831.3, filed June 27, 2002, pursuant to 35 U.S.C. 119(a)-(d), the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to an arrangement for maintaining a machine element at a controlled temperature in electrically operated production machines.

[0003] The temperature control of machine elements in electrically operated production machines has an impact on the quality of manufactured articles. Normally, a constant quality of the workpiece can be realized only after a stationary temperature level has been reached in the machine, in particular, e.g. ball bearing and guide that are subject to thermal influences.

[0004] The website www.rwth-aachen.de/ikv/Ww/abt.sg/masch.html by the Rheinisch-Westfälischen Technischen Hochschule RWTH Aachen (*Technical University of Rhineland* Westphalia) discloses devices for a dynamic mold temperature control. Injection molding of thermoplastic material may require not only a rapid cooling of the molded articles but also a momentary or local heating. In order to implement a dynamic temperature control, various circulations of liquids at different temperatures and the use of auxiliary electrical heaters has been proposed here.

[0005] It would be desirable and advantageous to provide an improved arrangement for maintaining a machine element at a controlled temperature in electrically operated production machines to obviate prior art shortcomings in a simple and cost-efficient manner.

SUMMARY OF THE INVENTION

[0006] According to one aspect of the present invention, an arrangement for maintaining a machine element at a controlled temperature in electrically operated production machines includes in combination an electrically operated production machine having at least one electrically operated motor and a machine element, and a temperature control system for maintaining the machine element at a controlled temperature, with the temperature control system including a heating unit for using thermal losses generated by the motor to heat

the machine element.

[0007] According to another feature of the present invention, the heating unit may include a heat exchanging circuit for directing the thermal losses of the motor to the machine element. Compared to open-loop circuits, closed-loop circuits are easier to control when subjected to adverse effects from environmental impacts.

[0008] According to another feature of the present invention, the heating unit may be a heat exchanger which forms part of the motor. Attachment of the heat exchanger to the motor optimizes heat dissipation of the motor for use in the process, regardless whether a closed-loop system or an open-loop system is involved. In a simple case, the heat exchanger can be constructed to have at least one tube for ensheathing the motor. The tube may be arranged as a single coil or in multi-coiled configuration. Of course, the arrangement of several parallel tubes in single-coil configuration is conceivable as well. Suitably, a liquid or gaseous fluid is used for circulating through the heat exchanger because heat exchangers of this type have proven reliable in other applications. The term "circulating" in this context is used here in a generic sense and includes a fluid flow around the machine element or through the machine element.

[0009] According to another feature of the present invention, there may be provided an active conveying unit which is operatively connected to the heat

exchanging circuit. Unlike a fluid circulation depending purely on gravity, the provision of an active conveying unit can significantly increase the efficiency of the system as far as heat transport is concerned.

[0010] According to another feature of the present invention, there may be provided a cooling element for decreasing a heat flux dissipated from the motor. In this way, it becomes possible to decrease the motor temperature, if need be. There may, however, also be a situation, when the heat flux dissipated by the motor should be increased. Therefore, it is suitable to further provide a separate heating element, when the heat generated by the motor is not enough to raise the temperature of the entire process of the machine to the desired level. This may occur, in particular during a startup phase.

[0011] According to another feature of the present invention, the motor may include a motor control for controlling the motor such as to exploit the thermal losses thereof to heat the machine element. In this way, the motor is not controlled exclusively according to boundary conditions in relation to the motor efficiency, but the focus can be shifted more to the overall process in order to influence the lost heat generated by the motor through the motor control in a desired manner.

[0012] According to another feature of the present invention, there may be provided a bypass which circumvents the machine element to allow a decrease

of a heat flux through the machine element. Such a bypass exhibits only a slight flow resistance in relation to the parallel branch containing the machine element. Of course, it is also conceivable to use valve assemblies to control a fluid flow through the machine element and bypass. In other words, the fluid flow may be switched to flow entirely through the machine element or the bypass.

[0013] With an arrangement according to the present invention, it is possible to heat machine elements of the production machine to a nominal temperature before the production of standard articles commences. The presence of rejects encountered during start of the production as a result of insufficient heating can thus be reduced.

BRIEF DESCRIPTION OF THE DRAWING

[0014] Other features and advantages of the present invention will be more readily apparent upon reading the following description of currently preferred exemplified embodiments of the invention with reference to the accompanying drawing, in which the sole FIG. 1 shows a schematic illustration of an arrangement for maintaining an exemplified machine element at a controlled temperature in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] The depicted embodiment is to be understood as illustrative of the invention and not as limiting in any way. It should also be understood that the drawings are not necessarily to scale and that the embodiment is sometimes illustrated by graphic symbols, phantom lines, diagrammatic representations and fragmentary views. In certain instances, details which are not necessary for an understanding of the present invention or which render other details difficult to perceive may have been omitted.

[0016] Turning now to FIG. 1, there is shown a schematic illustration of an arrangement for maintaining an exemplified machine element ME of a production machine at a controlled temperature in accordance with the present invention, with the production machine also including a motor MO. The machine element ME, shown here only by way of example, is an aggregate made of two plate-shaped components 1 which are moveable in relation to one another via a four-column assembly having columns 2 formed with interior bores 3 for through flow of a heat-exchanging fluid, e.g. a liquid or a gas. Examples of a liquid fluid include water, oil, emulsions etc. The non-limiting example of the novel and inventive arrangement shown in FIG. 1 is constructed as a closed-loop circuit WK in order to realize a heat distribution, whereby the closed-loop circuit through the individual components of the arrangement is shown here by way of continuous arrows.

[0017] In order to control the temperature of the machine element ME, heated fluid is introduced into the columns 2. Heretofore, the temperature of the fluid has been raised to the desired level through use of a separate heater. This is disadvantageous because of the demand for significant electric power. This drawback is now eliminated by exploiting the heat generated by the electric motor MO as part of the production machine and dissipated during operation as electric energy. In accordance with the invention, the fluid is now heated in a heat exchanger WT which is incorporated in the heating circuit WK. In the non-limiting example of FIG. 1, the heat exchanger WK is constructed as a tube coil wrapped around the motor MO. It will be understood by persons skilled in the art that the tube coil is shown here by way of example only. Of course, the incorporation of more complex heat exchangers in the motor MO is within the scope of the present invention.

[0018] Fluid exiting the machine element ME is returned via conduit 4 to a cooling element KE, whereby an active conveying unit is disposed in the heat exchanging circuit WK. An example of a suitable conveying unit is a common conveying pump with electric drive. In the example of FIG. 1, the cooling element KE is configured in the form of a radiator that is typically finds application in the automobile industry. Of course, any other configuration of a cooling element is conceivable as well. It will be appreciated by persons skilled in the art that the cooling element KE must contain much mechanical apparatus which does not appear in the foregoing Figures, e.g. fans. However, this apparatus, like

much other necessary apparatus, is not part of the invention, and has been omitted from the Figures for the sake of simplicity. Also, the present invention is not limited to the configuration of the cooling element with a coiled tube, as other configurations may be applicable as well.

[0019] In order to enable a rapid decrease of the heat supply to the machine element ME, the arrangement includes a bypass B for the coolant. Hereby, the flow resistance of the bypass B should be as low as possible in relation to the flow resistance of the machine element ME. Opening of the bypass B may be implemented through closure of a bypass switch BS.

[0020] As further shown in FIG. 1, the arrangement may also include a heating element HE in the heat exchanging circuit WK to assist a heat-up of the fluid to the desired temperature level. Suitably, the operation of the motor MO is controlled by a motor control MOS by which the motor can be operated to not only realize a desired process speed but also to control the encountered lost heat in response to process requirements. For example, a quick heating can be implemented during the starting phase of the machine. In this case, the use of the heating element HE may be omitted.

[0021] Although FIG. 1 shows the machine element ME for temperature control of guides, it is, in principle, also possible to supply other motor components, e.g. bearings, with a pre-heated fluid.

[0022] Although FIG. 1 describes a circuit WK as a closed-loop system, it is, of course, also possible to use an open-loop system. This may be suitable in those situations when ambient air is used as fluid. In this case, heat generated by the electric motor and carried away with the assistance of a fan can be routed via a duct system or baffles directly to the components to be heated and released from there into the environment. Such an open-loop circuit is simple in structure, although the temperature cannot easily be maintained at a desired level.

[0023] While the invention has been illustrated and described in connection with currently preferred embodiments shown and described in detail, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention. The embodiments were chosen and described in order to best explain the principles of the invention and practical application to thereby enable a person skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

[0024] What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims and their equivalents: